# Nuclear Energy Plant Optimization (NEPO)

*Office of Nuclear Energy, Science and Technology*
*U. S. Department of Energy*

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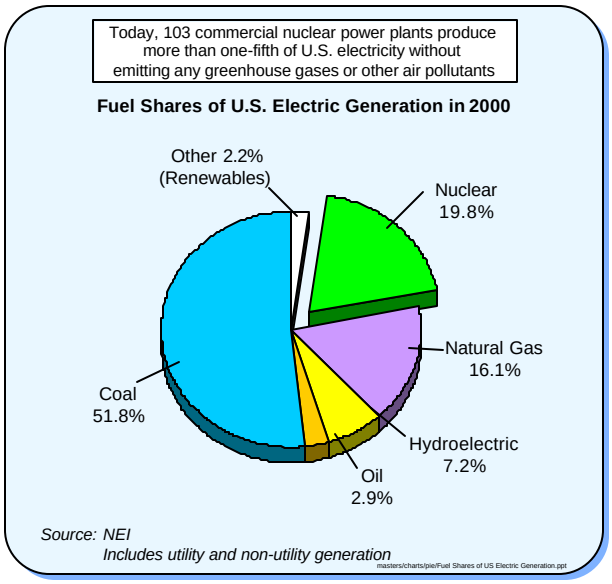
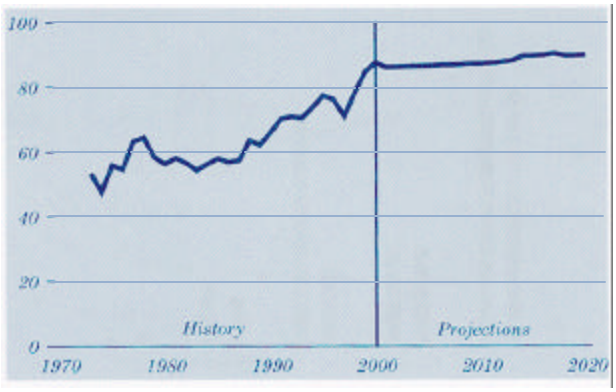
## Background

Among the baseload electricity generation options available today, only nuclear power plants can provide large supplies of reliable baseload electricity without contributing to regional air pollution or global greenhouse gas emissions. The continued operation of the Nation's 103 nuclear power plants can provide a reliable, economical source of energy during this period of uncertain change as the electric utilities transition to a more fully deregulated industry. These power plants provide approximately one-fifth of the Nation's electricity. Further, in many regions of the nation, the loss of nuclear power plants would not only have negative environmental impacts, but also threaten the overall reliability of the electricity systems in several areas of the country.




DOE's Energy Information Administration (EIA) anticipates that, even with aggressive implementation of energy efficiency measures, U.S. electricity consumption will increase 1.4 percent each year through 2020 – the equivalent of building seven large 1,000-megawatt power plants every year. Additionally, EIA projects that between 1999 and 2020, approximately 89,000 megawatts of existing electricity generating capacity will be retired because of age, competitive pressures, and as part of U.S. utility efforts to meet clean air standards. As a result, the EIA estimates the U.S. must build the equivalent of 1,000 new fossil fuel generating plants by 2020 to meet growth in demand and offset plant retirements. Building these plants will require a huge economic investment in new baseload generating capacity during the next two decades, and when in operation, these plants will emit large quantities of air emissions. According to EIA, nuclear energy could be key to reducing

Nuclear Power Plant Capacity Factors, 1973-2020 (percent)
***NEPO Vision: Achieve average industry capacity factor of 93% by 2010***




*Source: Annual Energy Outlook 2002*

carbon emissions. Operation of existing nuclear power plants annually avoids over 150 million metric tons of carbon, about five million tons of sulfur dioxide, and 2.4 million tons of nitrogen oxides. Continued operation of existing nuclear plants through their original license term and a 20-year renewed license term would partially mitigate the need to build more baseload power plants.

The United States is at an important juncture with regard to continued operation of its nuclear power plants. Initial 40-year license periods for many U.S. nuclear power plants will conclude by the end of this decade. The Nation's existing fleet of operating nuclear power plants has significantly improved their operating performance and safety during the past two decades. Average industry operating capacity factors have improved from 58 percent to over 90 percent and over 80 percent of the 103 operating plants are actively pursuing 20-year extensions to their operating licenses. As these plants near the beginning of the extended license period, the owners must provide continuing assurance to the Nuclear Regulatory Commission that the critical plant components and systems remain able to perform their intended safety functions. Research and development will play a key role in forming the technical basis for long-term operability assurance.

Recognizing the broad national strategic interests served by nuclear power, the Department initiated the Nuclear Energy Plant Optimization (NEPO) program in FY 2000 in response to the recommendations of the President's Committee of Advisors on Science and Technology (PCAST). As a cost-shared program with the industry, NEPO seeks to develop and apply new technologies to improve plant reliability, availability, and productivity while maintaining a high level of safety. Overall, NEPO aims to help increase the capacity factors of existing nuclear power plants to 93 percent by 2010. The Department and the electric utility

industry's Electric Power Research Institute (EPRI) developed the *Joint DOE-EPRI Strategic Research and Development Plan to Optimize U.S. Nuclear Power Plants* to initially guide the program and ensure the effective execution of essential R&D needed to sustain and enhance operation of existing nuclear power plants. This report, first issued in March 1998, utilized input from the Nuclear Regulatory Commission (NRC), utilities, national laboratories, and other key stakeholders. Future areas of focuses for the program will include development of technologies that will allow more extensive power uprates and enhance nuclear security programs at existing plants.

The Nuclear Energy Research Advisory Committee (NERAC) provides the Department advice on the conduct of the NEPO research and development program.

The goal of the NEPO program is to increase the electrical generating capacity of the existing fleet of U.S. Nuclear power plants through the development of advanced technologies to achieve continued capacity factor improvements, advanced extended power uprates, and enhancing the capability of U.S. nuclear power plants to continue operating efficiently in the long-term future. The objectives related to this goal are:

- Managing long-term effects of component aging: component and structural material degradation occurs in nuclear plants as a result of long-term operation and exposure of materials to harsh environmental conditions. Technology development under the NEPO program will provide capabilities to easily prevent, detect or repair the degradation. This will in turn facilitate continued increases in industry generating capacity
- Improving generation efficiency and productivity: Current nuclear plants were designed and are operating with technology developed over 25 years ago. As these nuclear plants age, components and parts degrade or become obsolete, introducing inefficiencies, added costs, and unreliability. NEPO focuses on improving the long-term economic performance of current plants through development of technologies that will improve equipment reliability, lower operating costs, and increase power output while maintaining high levels of safety.

The NEPO program has made significant progress toward addressing many of the material aging and generation optimization issues which have been identified as the key long term issues facing current operating plants. Recent results from the NEPO program include a determination of the optimum amount of zinc which should be added to a typical pressurized water reactor to reduce the possibility of cracks developing in some of the significant components of the reactor; the development of new electrical cable monitoring techniques for improved prediction of cable lifetimes; the development of techniques to qualify smart transmitters to replace existing analog transmitters which are less accurate and difficult to maintain; the development of an industry consensus approach for implementing digital upgrades to existing nuclear power plant safety systems; and the determination of the optimum fuel burn up and operating cycle for both the pressurized and boiling water reactors. Further highlights of the NEPO program are contained in the *Nuclear Energy Plant Optimization (NEPO) Program Annual Report for FY 2001,* dated February 2002 (see http://nepo.ne.doe.gov).

**FY 2001 Accomplishments:**

- Continued 10 R&D activities initiated in FY 2000.
- Initiated 8 new projects.
- Issued update to the *Joint DOE/EPRI Strategic R&D Plan to Optimize U.S. Nuclear Power Plants, Volume II.*

**FY 2002 Accomplishments:**

- Complete 5 R&D projects; continue 11 R&D projects initiated in prior years.
- Initiate 11 new projects.
- Issue update to the *Joint DOE-EPRI Strategic R&D Plan to Optimize U.S. Nuclear Power Plants, Volume II.*
- Issued first NEPO Annual Report

**FY 2003 Plans:**

- Using prior year funds, 11 projects initiated in prior years will be completed.
- Initiated up to 15 new projects identified and selected through an open soliciation and merit-based peer review process.

**Program Budget**
**NEPO**
($ in Millions)

| FY 2002 Appropriation | FY 2003 Appropriation | FY 2004 Request |
|---|---|---|
| $6.3 | $5.0 | $0.0 |